The Detroit-Windsor Air Pollution Study

The dramatic Donora disaster of 1948 brought renewed attention to atmospheric contamination and its effects on health conditions. In several sections of the country significant studies and extensive control programs are now under way.

Some of these were reported upon during the 1952 Industrial Health Conference in Cincinnati, Ohio, April 19–26. The Detroit-Windsor air pollution study—an integrated project with industrial, local, State, national, and international participation—was the subject of a symposium on April 22 jointly sponsored by the American Conference of Governmental Industrial Hygienists and the American Industrial Hygiene Association. Public Health Reports presents here, in brief, the six major papers.

Objectives of the Detroit-Windsor Air Pollution Study

PHR brief

The International Joint Commission of the United States and Canada was established by treaty in 1909. In article IX of the treaty, the Commission is given legal authority to study atmospheric pollution problems along the common frontier between the United States and Canada.

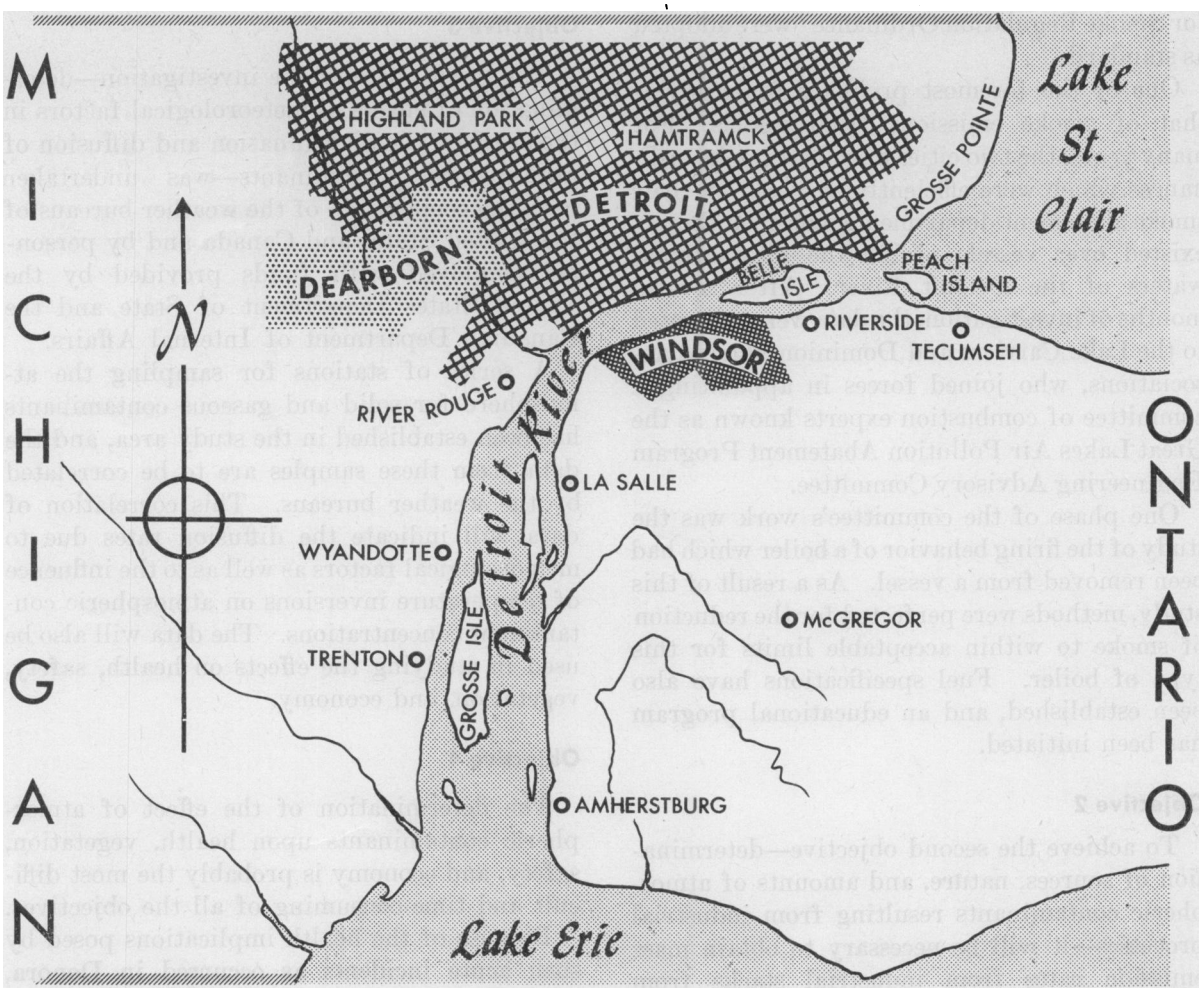
The Commission itself is not authorized to pass legislation, but it is required to make a joint report of every investigation with recommendations to both governments, who may then act upon the recommendations, giving them the force of law.

By George D. Clayton, B.S., sanitary engineer with the Division of Occupational Health of the Public Health Service, and chairman of the American Section, Technical Advisory Board on Air Pollution of the International Joint Commission of the United States and Canada.

As a result of complaints from Detroit, Mich., and Windsor, Ont., on both sides of the international boundary (the Detroit River), the United States and Canada in 1949 presented a joint reference to the International Commission, stating that the air in the vicinity of the two cities was polluted by smoke, soot, and fly ash discharged from vessels passing through the river. The joint reference requested the Commission to recommend remedial measures which would be economic and sanitary and to make a decision as to who would bear the cost.

The International Joint Commission established a Technical Advisory Board on Air Pollution, composed of three representatives from each government. The purpose of the board is to give technical direction to field work, to plan the studies on both sides of the boundary, to review the findings periodically, to discuss the significance of the data accumulated, and to make recommendations to the Commission. The board held its first meeting on May 12, 1949, at Windsor.

Although the joint reference outlined the



The area of the air pollution study

scope of the study, it did not define its area, except for providing that it include the entire length of the Detroit River. The Technical Advisory Board decided that the boundary would stretch from Peach Island at the north end of the river to Grosse Isle at the south end, extending 15 miles inland on each side of the river.

Early in the planning, it became apparent that sufficient funds to conduct the investigations would not be forthcoming from the national governments. It was therefore necessary and desirable to obtain the cooperation of those agencies within the community which are responsible for the health and welfare of the people. Various State, Provincial, local, and national organizations, including the CIO and the AFL, have thus been approached.

Advisory boards of leaders in the engineering and medical fields have been organized to assist in planning, guiding, and promoting the study. Many conferences have also been held with city officials.

Five objectives have been established for the Detroit-Windsor air pollution study.

Objective 1

Under the first objective—determination of sources, nature, and amounts of atmospheric contaminants resulting from combustion of fuels—the amount of pollution from fuel combustion of vessels, railroads, and domestic, industrial, and automotive sources will be ascertained.

The Ringelmann chart for estimating the intensity of smoke and the American Society of Mechanical Engineers code "Example Sections

for Smoke Regulation Ordinance" were adopted as standard.

One of the foremost problems for study is that of smoke emissions from vessels. For many years, the two cities have had smoke ordinances which were efficiently enforced by their smoke abatement departments, but no authority existed over vessels plying the international waters of the Detroit River. After several months of investigation, the data were presented to the Lake Carriers and Dominion Marine Associations, who joined forces in appointing a committee of combustion experts known as the Great Lakes Air Pollution Abatement Program Engineering Advisory Committee.

One phase of the committee's work was the study of the firing behavior of a boiler which had been removed from a vessel. As a result of this study, methods were perfected for the reduction of smoke to within acceptable limits for this type of boiler. Fuel specifications have also been established, and an educational program has been initiated.

Objective 2

To achieve the second objective—determination of sources, nature, and amounts of atmospheric contaminants resulting from industrial processes—it will be necessary to obtain mass emission rates from industrial stacks from which toxic materials and other contaminants are discharged into the atmosphere.

The Technical Advisory Board requested the division of industrial health, Michigan Department of Health, to obtain data from industry within the study area outside Detroit's city limits. Within the city limits, the bureau of industrial hygiene of the Detroit Department of Health was requested to assume similar responsibility. Because of the magnitude of the task, industry was requested to supply data on its own stack emissions. The excellent community spirit prevailing in Detroit and Windsor was shown by the support which industry has given to the study.

The larger participating industries were interested in acquiring more knowledge on the sampling and analysis of stack effluents. To meet this demand, a semester course of 18 lectures was established at the University of Michigan.

Objective 3

The third phase of the investigation—determination of effects of meteorological factors in the areas on the dissemination and diffusion of atmospheric contaminants—was undertaken with the cooperation of the weather bureaus of the United States and Canada and by personnel employed with funds provided by the United States Department of State and the Canadian Department of Internal Affairs.

A series of stations for sampling the atmosphere for solid and gaseous contaminants has been established in the study area, and the data from these samples are to be correlated by the weather bureaus. This correlation of data will indicate the diffusion rates due to meteorological factors as well as to the influence of temperature inversions on atmospheric contaminant concentrations. The data will also be used in studying the effects on health, safety, vegetation, and economy.

Objective 4

The determination of the effect of atmospheric contaminants upon health, vegetation, safety, and economy is probably the most difficult and time-consuming of all the objectives.

Because of the health implications posed by such acute incidents as occurred in Donora, there is great need to study the chronic, or long-range, effects of air contaminants on health. This is being undertaken jointly by the Public Health Service, the Canadian Department of National Health, and the Detroit City Health Department.

A more obvious problem is evaluation of the effects of atmospheric contaminants on vegetation, which is evident in the stunting of growth, loss of vigor, and reduction in crop yield. Air pollutants also present a threat to a community's civic beauty as well as to the prosperity of its outlying area. The technical board will request the assistance of a well-qualified organization to undertake this phase of the study.

There is need also to consider the effect of atmospheric pollution on safety. Studies will be made to determine what effects, if any, concentrations of various contaminants have upon aviation, automotive, and pedestrian safety. Appropriate organizations will be requested to

participate in studying the effects of air pollutants on aviation safety. This investigation will also include a study of the economic factors involved in air pollution and its effect on closed airports. The United States Weather Bureau and members of the technical board will cooperate in the undertaking of this study.

Objective 5

The last objective will be the determination of what controls are necessary, their cost, and by whom the cost should be borne.

Smoke is the only air contaminant for which workable data are available. Acceptable standards have been established for smoke emissions. Moreover, much research has been done on the control of smoke, permitting a fairly accurate survey of the cost of control procedures necessary to control smoke emissions within permissible limits. This is not true of other atmospheric pollutants. Data on standards for the emission of toxic gases and particulate matter into the atmosphere are insufficient.

During the investigative phase of the air pollution study, no attempt will be made to establish definite limits for the emission of toxic materials into the atmosphere surrounding industrial plants. No attempt will be made to establish limits for toxic materials found in community atmospheres. The study will seek to determine the effects of each individual contaminant, its relationship to other contaminants, and the practicability of certain control procedures. Only after careful review of all available information obtained during the course of the investigation will any attempt be made to recommend control measures for alleviating the atmospheric pollution problem.

Statistical Analyses in Air Pollution Studies

PHR brief

Air pollution can be studied successfully only when a wide variety of approaches is employed. In contrast to strictly experimental work where most environmental conditions are controlled, statistical analyses of air pollution must deal with phenomena upon which the influence of many important factors is unknown.

Experimental animals in a laboratory can be kept in a relatively stable environment while the magnitude and duration of exposure are varied. But the composition and environment of human populations can never be maintained at the same level. Although people may be exposed to similar atmospheric contaminants, they live and work under diverse conditions. Chemical substances in the air are found in complex mixtures.

The statistical approach to studying uncontrolled phenomena offers the best hope of finding solutions. To be of greatest assistance on an air pollution study, the statistician should be a member of the research team in the planning stages.

Design of the Experiment

In any investigation, the objectives cannot be fully developed until certain facts about the community are known. In the Detroit-Windsor study, maps were available in the office of the city assessor, showing the ownership and boundaries of all industrial properties in Detroit. City air pollution inspectors were assigned throughout the city to determine from the assessor's maps which plants in their districts were contributing to air pollution.

Industrial plants were classified by type of smoke emission—active and inactive solids and active gases—and were then divided into heavy or minor pollution classifications. This information was transferred in symbol form to census tract maps of Detroit. It was thus possible at the onset of the study to visualize where the atmosphere was being contaminated and with what type of contaminant. Additional information was obtained from the public utility company, from a newspaper, and from regional planning maps.

The biological phase of an air pollution study involves the delimitation of socioeconomic areas. Basic data for this objective must be as-

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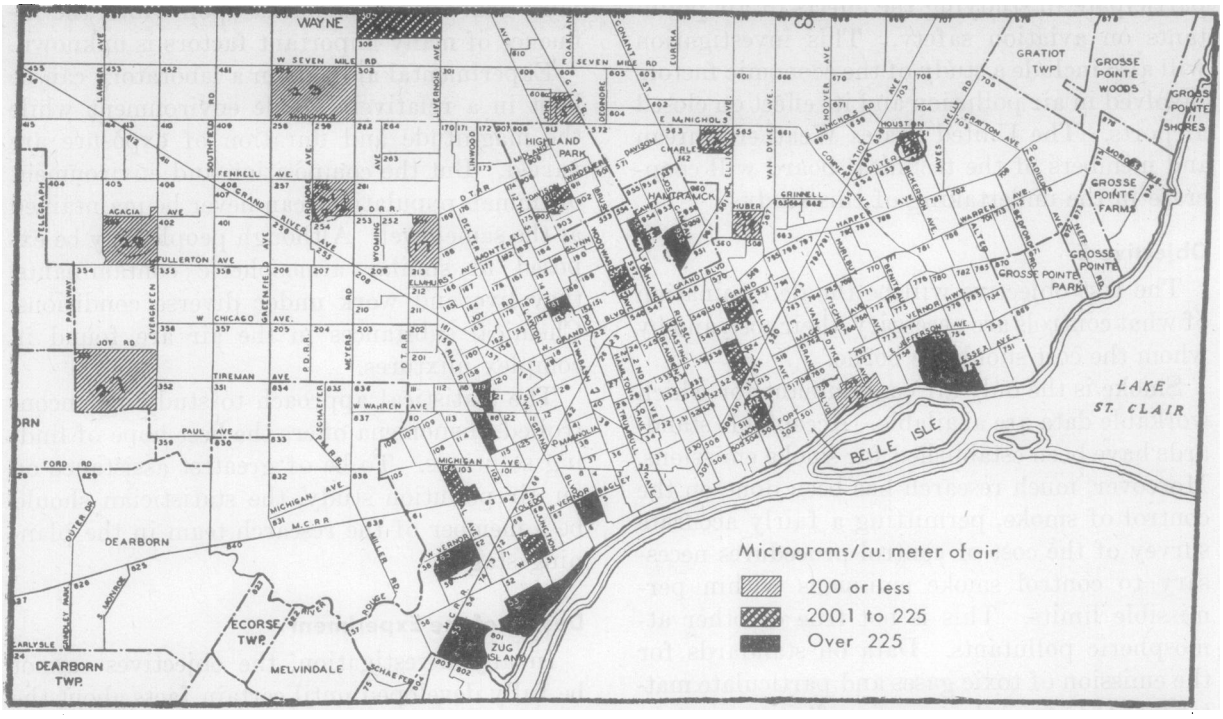

Figure 1. Census tract maps of Detroit are used throughout the air pollution study. This one shows the median weights (in micrograms per cubic meter of air) of total particulate matter based on air samples collected in selected census tracts in the Detroit area for the period May 7 through June 17, 1951.

sembled from a variety of sources, a task well suited to the statistician. In the Detroit-Windsor study, census tract information was sought from the United States Bureau of the Census on such topics as the 1950 count of population, 1940 census data for percent of nonwhite population, percent of foreign-born population, median years of schooling, percent of homes with mechanical refrigeration, and percent of owner-occupied homes.

A local sample survey made in 1946 provided economic ratings by census tract. The Council of Social Agencies furnished current data on relief cases, aid to dependent children, and old-age assistance. The juvenile court furnished data on the residence of youthful offenders. The interracial commission estimated changes in the proportion of Negroes since the 1940 census. The health department prepared information on vital statistics—total death rates and infant and tuberculosis death rates. Utilizing such information, the statistician prepared census tract maps, shading the variations within the city.

Figure 1 is an example of a census tract map used to pinpoint the amounts of total particulate matter collected in selected areas.

Once the sources of pollution have been spotted and the socioeconomic areas delimited, the groundwork for intelligent planning has been laid.

Operation of the Study

In the active phase of the study, the tasks of the statistician will multiply rapidly. Air-sampling stations should be located with regard to the adjacent human populations. The maps showing emission sources and classifying census tracts by socioeconomic status are needed to locate air-sampling stations. Census tracts should be grouped by pairs having relatively similar socioeconomic status but different amounts of air pollution. Since it was practicable to operate only a certain number of sampling stations, they were distributed on a random geographic basis among the approved census tracts.

An equally helpful study would be a statistical investigation of the health of people in sam-

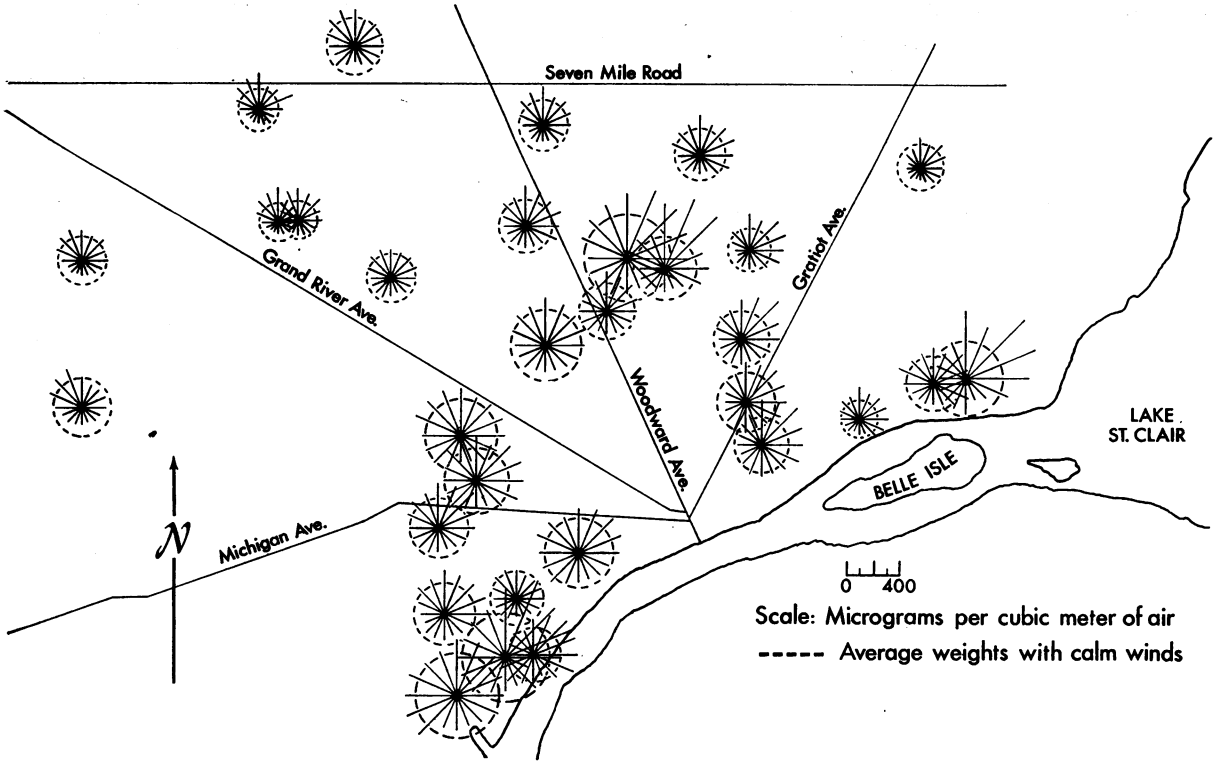

Figure 2. The above map of Detroit shows average weights (in micrograms per cubic meter of air) of total particulate matter according to wind direction for each of 31 sampling stations, based on daily air samples collected in the Detroit area, May 7 through June 17, 1951.

ple areas. Such a study might include a continuing record of the sickness experience of selected groups subjected to varying degrees of air contamination. Because of the infrequent occurrence of many diseases possibly related to air pollution, selection of the sample size is of major importance. The unit chosen for sampling might be a random selection of families in a designated census tract or in selected areas within the tract.

In planning the number of interviewers, estimates are needed on the average daily number of home visits to be expected of each worker. The time interval between interviews has been found to have a marked influence on the morbidity rates obtained. Field surveys of morbidity are but one of many possible means for the evaluation of health conditions. The statistician can assist in devising better and less costly methods for use of the other sources.

Analysis and Presentation of Findings

The validity of findings from any air pollution study will depend upon a comprehensive statistical analysis of the data. Such analysis should partially answer the following questions: Which areas are more heavily polluted in terms of specific contaminants? How does the concentration of various contaminants in different areas vary with changing weather? Is there a common behavior pattern of the specific contaminants? Is there any over-all measure of air pollution to use as an index in ranking different areas in terms of average air pollution?

The statistician will select appropriate descriptive constants to facilitate comparisons among sampling stations. The medians may be used to represent an average value of a given contaminant at different stations and to rank the stations with respect to average concentration of the contaminant. Since sample weights represent average values of the contaminant for time intervals of equal length, the median may be considered the concentration of the contaminant which was equalled or exceeded in the atmosphere during half of the period under investigation.

The degree of concentration at the various

stations can also be measured by selecting a given concentration value and determining the proportion of sample values which equal or exceed it. This approach can supplement the information given by the median value. By fixing the concentration values at a relatively high level, heavily concentrated areas can be identified.

To investigate the relationship between weather and air pollution, the day-by-day weights of total particulate matter for one station and the average daily weights for all stations may be plotted in a time series. Weather conditions may be compared with these graphs, and strongly associated cyclic patterns may be observed.

The amount of contamination at a given air-sampling station can be related to the prevailing wind direction. To do this, multiply each daily weight of total particulate matter by the number of half-hours in the day when the given set of wind directions existed; sum up all days of the study period, and divide the sum by the total number of half-hours in the study period for this category of weather conditions. A map can then be prepared to show a sampling station with bars radiating from it in wind directions (see fig. 2). The length of each bar is proportional to the amount of particulate matter observed when the wind was blowing in a given direction.

Environmental Studies—General Area Sampling

PHR brief

The population and industrial centers on both sides of the international boundary at the Detroit River may be considered as one area. A region of about 3 million inhabitants, it is one of North America's greatest concentrations of industry.

By Morris Katz, M.Sc., Ph.D., chairman, Canadian Section, Technical Advisory Board on Air Pollution, International Joint Commission.

Estimates place the annual domestic and industrial consumption of coal and solid fuels in the area at about 15 million tons on the United States side, and 650,000 tons on the Canadian side. Including the total from all sources, the coal consumed by vessel traffic on the Detroit River is conservatively estimated at 16 million tons. The average sulfur content of this fuel is at least 1.5 percent, and about 90 percent of the sulfur is released into the atmosphere during combustion. On this basis, approximately 430,000 tons of sulfur dioxide are emitted to the air annually from solid fuels alone, to be further augmented by the sulfur oxidation products from the combustion of natural gas, fuel oil, gasoline, and from such sources as metallurgical, chemical, and paper mill operations.

Among other toxic gaseous contaminants which have been found in this area are hydrogen sulfide, chlorine, oxides of nitrogen, and ammonia. Data obtained for these contaminants are meager in comparison with the continuous sulfur dioxide observations and, therefore, serve only to indicate the nature of the hazard.

The environmental studies have been designed to determine the maximum, minimum, and average pollution as influenced by meteorological and other factors over a sufficiently long period, and to evaluate their effects on health, economy, safety, and vegetation.

Obviously, such studies call for continuous observation and sampling techniques on an area basis. No adequate knowledge of diurnal variation, and of weekly, monthly, and yearly cycles of pollution can be obtained other than by the continuous sampling technique. A comprehensive picture of pollution is difficult to achieve by intermittent sampling methods. Meteorological factors, which cause great variations in pollution, are operative throughout the 24-hour day and fluctuate with the seasons. Environmental evaluations must be approached on this basis.

Sulfur Dioxide Pollution

The rise and fall of the level of sulfur dioxide in the air has been chosen as an index of gaseous pollution since the gas is one of the major contaminants in quantity in the area. Four con-

tinuous-test stations have been in operation in the Greater Windsor area where Thomas autometers have been located at three stations in the more heavily contaminated portion.

In view of the high persistence of winds from the north, northwest, west, and southwest directions, the sulfur dioxide observations at these stations are influenced by effluents from sources on both sides of the international boundary. The mean concentration at each autometer station has been calculated for every 30-minute period of the day. Peak concentrations over shorter time intervals have also been evaluated whenever such peaks have indicated unusual fluctuations in concentration. A comparison of the monthly means for 1951 indicates the existence of two seasonal peaks in the pollution load, occurring in the spring months of April and May, and in the late fall and early winter period.

The pollution load, as indicated by variations in intensity and frequency of sulfur dioxide fumigations, shows marked seasonal as well as diurnal trends.

Smog visitations of several days' duration have been noted during temperature inversion periods in the area. Highest frequency of occurrence was April, May, and July and from October to December. Relatively high peak concentrations of sulfur dioxide have been noted during such visitations.

In the light of what is known of pollution in other industrial areas, such peak concentrations, as well as the mean values, indicate more serious sulfur dioxide conditions in the Detroit River area than in such polluted zones as Los Angeles, Yonkers, N. Y., some of the industrial regions of Great Britain, and even the Trail, B. C., area, before the full employment of remedial measures. The possibility of a major disaster in the Detroit River area is rendered unlikely only on the grounds of its topography, but, with increasing industrialization, toxic levels of pollution are being built up to serious proportions.

Distribution of Suspended Particulate Matter

The zones of high, medium, and low pollution with reference to aerosol concentrations have been investigated by continuous high volume filtration units set up at 30 stations on the United States side and 25 on the Canadian side of the boundary. These units sample the air at a rate of about 50 cubic feet per minute, and collect the aerosol contaminants on specially prepared pleated paper filters, which are changed every 24 hours. High concentrations of particulate matter usually coincide with periods of smog and relatively heavy sulfur dioxide fumigations.

Delineation of areas of heavy, moderate, and low pollution has been attempted on the basis of the mean and maximum concentrations of particulate contaminants from the continuous filtration data. In general, the most heavily polluted areas on the Canadian side lie close to the river. The areas of heavy pollution also lie within the zones which contain the major industrial operations. The areas of moderate to low pollution are located to the east and south of Windsor, with the lowest values of all shown by the sampling stations located at Tecumseh and McGregor, Ont. There is about a threefold increase in mean concentration of particulate matter between the lowest and the most heavily polluted areas.

Distribution of Deposited Matter

The distribution of deposited matter, or dustfall, has been studied by analyses of data from 20 sampling sites in the greater Windsor area. In the heavily polluted area, the mean dustfall for all stations is about 92 tons per square mile per month. In the heavy to moderate pollution area, the mean dustfall is 53.9 tons per square mile per month, whereas in the moderate to low pollution zones the mean dustfall ranges from 42.7 to 35.9 tons per square mile per month. Here, as in the case of the suspended particulate matter, there is also a threefold increase in the pollution load in passing from the low to the heavily contaminated areas.

The average monthly dustfall pollution in the heavily contaminated area of Windsor is apparently greater than that reported recently for Chicago, Cincinnati, and Los Angeles, for Toronto, Canada, and for Pittsburgh.

There is a considerable difference in the composition of deposited matter and suspended matter in coal-burning areas. Particles which remain suspended in city air may consist of 85 percent by weight of tar and combustible or-

ganic matter, and only about 15 percent of ash, whereas deposited matter may contain upwards of 70 percent ash.

Nature of Suspended Particulate Matter

The chemical nature of the inorganic components of the complex aerosols in this environment has been studied by methods of X-ray diffraction and by spectrographic analysis. About 20 metallic elements have been identified in varying amounts. The most abundant are calcium, silicon, aluminum, and iron.

Public Health and Welfare

The air pollution disasters of the Meuse valley in Belgium and at Donora, Pa., have shown conclusively that unrestricted and excessive contamination of the atmosphere under adverse meteorological and topographical conditions may lead to acute episodes involving sickness and death from respiratory and cardiovascular disorders. The chronic effects of air pollution are not so clearly defined; nevertheless, the frequent occurrence of eye irritation and the smog damage to vegetation in the Los Angeles area during temperature inversions illustrate that such influences are also present. The Donora report has stressed the significance of a synergistic effect in air pollution so that the combined influence of a number of toxic contaminants occurring simultaneously may be far greater than the additive effect of individual contaminants. The specific surface and adsorptive capacity of small aerosol particles for gases and vapors, the role of condensation nuclei, and the deposition of sulfuric acid mist and other compounds on such nuclei may affect the respiratory system in a manner entirely different from that of similar concentrations and durations of relatively pure toxicants.

Statistics and correlations on the increased deaths from respiratory disease during smog visitations in English industrial communities have been reported. The loss of sunshine and decrease in ultraviolet irradiation have been considered as contributing factors in the occurrence of deficiency diseases such as rickets. There is, as yet, little experimental work available on the effect of air pollutants on the health of humans and animals in the concentrations and under the environmental conditions approaching those of the atmosphere of cities and industrial areas. It was the consensus at the conclusion of the United States Technical Conference on Air Pollution of May 1950 that pollution with allergenic material of industrial origin is associated with a frequent and apparently increasing occurrence of acute and chronic disease, involving especially the respiratory tract and the skin.

Although there may be some disagreement among authorities as to the magnitude of the chronic effects of excessive air pollution on public health, nobody will deny the existence of adverse effects on public welfare. Huge economic losses have been sustained in city areas from the accelerated deterioration of buildings, structural materials, corrosion of metals, plant and household equipment, injuries to textiles and other fabrics, and excessive laundry bills. The frequent occurrence of smog in densely populated areas, accompanied by poor visibility, has caused serious and costly traffic dislocation at airports and on highways. In rural areas, gas damage may result in retardation and killing of crop plants and forest growth, and erosion and poisoning of soils.

Industry's Part In the Study

It was expected that the information supplied, when evaluated, would give a fair picture of the combustion processes in the Detroit-Windsor area, and, at the same time, give a general idea of the degree of control now in effect. In addition, the evaluation should pinpoint a large portion of the potential sulfur sources.

Survey of Pollution Sources

The second major field of investigation was one which could become never-ending. It was covered by the request on the questionnaire that

By J. C. Radcliffe, M.Sc., supervisor, industrial health unit, Ford Motor Company, Dearborn, Mich.

"Companies operating plants which emit gases and solids into the atmosphere, other than ordinary products of combustion and fly ash, are to answer the following: (*a*) type of process; (*b*) list raw material used; (*c*) list finished products and approximate annual output; (*d*) nature of effluents; (*e*) height at which discharged; (*f*) methods adopted for reducing amount of this effluent."

A section for additional remarks was included, which undoubtedly was not wholly completed by many industries. Industry would be in an extremely enviable position if it had the answers to these questions. As it is, many industries have a long way to go in this direction, and the questionnaire results revealed an obvious lack of final data.

Coordination

It was indicated that the official agencies could perform some stack sampling along with type sampling in their areas. It was further indicated that the official agencies desired industry's cooperation wherever possible in a representative stack sampling program.

Thus, a separate technical committee was established through which official agencies and industry would coordinate techniques and sampling methods.

The next step was to develop agreement on the techniques and methods to be used in stack sampling. Various standard methods proposed by the American Society of Mechanical Engineers and other groups were reviewed. General rules were adopted on locating sampling points, measuring temperatures of stack gases, types of sampling equipment recommended, and types of materials to be analyzed.

Many representatives from industry were sent to the noncredit training lectures set up in 1951 with the University of Michigan extension service for instruction in the methods to be used in analyzing effluents from various stacks in the area. They have since begun their respective stack evaluations.

Stack Sampling

We have now passed beyond the initial mapping or planning stage. At present, most of the plants are approaching or are already in the sampling, evaluation, or correction phase of the industrial study. We have reached the point of agreement on the order in which the stacks should be sampled. Normally, those operations which are thought to be prime contributors from a visual viewpoint are put first, and minor ones last.

In order to insure a common sampling procedure, most industries plan to have similar-sized holes put in all stacks so as to require only one basic type of sampling probe. Industrial planning and engineering departments are being contacted so that any new process exhaust stacks can be fitted in their design stages with the standard hole for stack sampling.

Care is being taken in the sampling program to note variations due to time of day, week, and point in the process. Sufficient grab samples (10 minutes to 1 hour) are obtained to determine maximum, minimum, and average conditions. In some instances, as on powerhouse stacks, it is necessary to obtain samples during both winter and summer.

The results we are getting are interpreted to indicate the degree of air pollution. Where high results are obtained, further corrective action is indicated.

From an industrial viewpoint, the most promising aspect of the entire industrial study of factors contributing to air pollution is not primarily the correction of existing conditions but it is the designing and building of control devices to be incorporated into each new operation in the future. This type of control, planned before the foundation is laid for a building, in time will be of prime importance in controlling air pollution.

An invitation was extended to industry in the Detroit-Windsor area to discuss the proposed air pollution study to be conducted in that area. The meeting, held in September 1950, was attended by approximately 50 representatives of industry and technical personnel from official agencies.

As a start, industry's cooperation was requested in two major fields: the first, a survey of fuel and fuel-burning equipment used throughout the area; and the second, an inquiry into the sources of gases and solids discharged into the atmosphere in the area. To obtain the information it was decided that a questionnaire would be circulated to industrial plants.

Combustion Processes

For the first of the two major fields, questions were asked about the kinds of fuel burned (coal, coke, oil, gas, garbage, trash, and other); amount of fuel burned in 1949; type of fuel-burning equipment (hand-fired, underfeed stoker, spreader stoker, pulverized fuel, traveling grates); and the number and height of smokestacks.

Additional information was requested on auxiliary equipment, methods or operating procedures for reducing smoke or fly ash emission, and smoke indicators in use. Where coal or coke was used, questions were asked on the size, volatility, amount of ash and sulfur in percentage by weight on a dry basis; for oil, the percentage of weight of sulfur; and for gas, the percentage by volume of sulfur.

Environmental Studies—Meteorological Aspects

PHR brief

Although the environmental study of air pollution in the Detroit-Windsor area was begun nearly 2 years ago, the weather study is only in the organizational stage at this time.

The meteorological investigation will be an international undertaking with direct cooperation between the two national weather services. In addition, the weather facilities of the United States Air Force and the United States Navy, plus all available weather data from municipal and private sources, will be coordinated in the study.

It is evident that gaseous and particulate contaminants resulting from combustion and other industrial processes are continuously being released into the atmosphere. Because it is left to the atmosphere to rid us of these contaminants, it is common to speak of our aerial sewage system.

By Harold W. Baynton, B.A., research meteorologist, Meteorological Service of Canada

The atmosphere usually does its job well, but occasionally it loses its ability to carry off and disperse contaminants. It is obvious to everyone, for example, that the system has broken down when dense smoke and fog hang over the city, as they so often do early in the morning.

The meteorological study in the Detroit-Windsor area will be aimed at determining and evaluating the meteorological factors that control this property of the atmosphere to remove and disperse contaminants. It will be a study of the diffusing power of the atmosphere.

Weather and Air Pollution

At the present state of knowledge of air pollution, the position of weather has been summarized in the meteorological panel report issued in 1951 by the United States Technical Conference on Air Pollution:

"The average distribution of contaminants in a city is governed by wind, rain, atmospheric stability, and topographic features. The contaminants in their turn influence rainfall and fog occurrence and persistence."

In any metropolitan area, these elements of weather are always at work, tending to shift the regions of maximum pollution, to confine the pollution to relatively small volumes of air, or to disperse it rapidly through great volumes of air. We become fully alerted to the importance of weather in a study of air pollution when we realize that it was the development and persistence of special meteorological conditions that contributed to the disasters in the Meuse valley and, more recently, at Donora.

A meteorological study aimed at throwing light on the processes of air pollution will be primarily a study of winds, atmospheric stability, and precipitation. Each of these three major areas of investigation can be broken down in a number of ways. Winds can be analyzed from the standpoints of prevailing direction, frequency of calms, frequency of certain speeds, gustiness, diurnal and seasonal variations, and other factors. Stability can be analyzed directly from radiosonde data or other instrumental measurements of temperatures aloft, and indirectly from studies of surface temperatures, hours of sunshine, visibility, and frequency of fog.

Observation Network

In a scientific study of any kind, it is desirable to have more than one measurement of, and more than one method of measuring the quantities under consideration. To study the meteorological aspects of air pollution, it is useful to have a close network of observing stations throughout the area. It is then possible to study the micrometeorology of the area.

The Detroit-Windsor area is already well equipped from this standpoint. There are 23 stations in or near the area taking complete or partial observations. Many of the stations are operated by industry. From this network, there are available 9 measurements of surface wind, 12 measurements of surface temperature, 6 measurements of visibility, 7 measurements of atmospheric pressure, to mention a few, and single measurements of temperatures and winds aloft and hours of sunshine. It is planned to supplement the existing network with a few special installations. Before incorporating all the available data in a study of the micrometeorology of the area, observation procedures must be standardized. Otherwise, the various measurements would not be directly comparable.

Geographic Factors

It is interesting to speculate on the likelihood of an air pollution disaster in the Detroit-Windsor area. The two most notorious disasters (the Meuse valley, Belgium, and Donora, Pa.) both occurred in valleys. Valley walls create a natural vessel for pollution, inhibiting lateral diffusion. A valley creates a favorable environment for the development of an inversion which, in turn, serves to put a lid over the pollution and damp out vertical diffusion. The final meteorological condition for a disastrous fumigation seems to be the stagnation of a center of high pressure over the region, allowing the inversion to persist and intensify.

Records of the United States Weather Bureau reveal that for the Great Lakes area, summer is the favored time for air stagnation of high-pressure centers. This is also the season of maximum solar radiation, maximum instability, and, therefore, minimum frequency of inversions. In the case of Donora, it was found that anticyclones over the area were most common in October. October is also a month with relatively long nights, which are favorable for the formation of early morning inversion.

Therefore, from purely meteorological and geographic considerations, conditions favorable for a disastrous smog are less probable in the Detroit-Windsor area than in the Donora area. On the other hand, the tremendous concentration of industry in the area, and the unusually heavy steamboat traffic on the Detroit River are highly favorable for the occurrence of disastrous concentrations.

It is hoped that the meteorological study will reveal what conditions are prerequisites in this area for a disastrous smog, and what are the probabilities of its occurrence.

Environmental Studies—Health Aspects

An investigation which will yield a valid answer to "What effect does air pollution have on health?" is difficult to plan. Concurrently, answers to three other pertinent questions must be obtained as well:

What constitutes normal health in the affected population?

What are the criteria for impaired health?

What factors other than man-made air pollution adversely influence health?

Factors Influencing Health

The health of population groups is intimately related to numerous environmental and socioeconomic factors. Among the more influential of the latter are income, nutrition, medical care, race, family health and sanitation practices, and age of the population groups which are selected for study. Significant environmental

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factors include such aspects of housing as sanitation, overcrowding, physical recreation facilities and heating, man-made air contaminants, airborne disease-producing micro-organisms, pollens and other naturally occurring allergins, occupational exposures injurious to health, and weather. Also important is community sanitation—food, water, and insect and rodent control.

Once determined, socioeconomic influence in a given area remains fairly constant over a period of time. The ambient factors, such as man-made air contaminants, air bacteria, pollens, and weather must be measured accurately and continuously over the entire study period.

The collection of information on weather and on air contaminants is another phase of the air pollution study, but the data are collected so as to be directly applicable to the health study.

Preliminary Area Studies

It was apparent that a complex study of this nature involving a very large population group would have to be conducted according to sound statistical procedure. Samples of the area and population would have to be so selected that accumulated data could be treated by valid statistical analysis. Planning of the study was placed under the supervision of statisticians who would be responsible for the eventual analysis of the data. Under their direction, a thorough investigation was made to determine if satisfactory sample areas could be established with significant differences in respect to the several measurable environmental factors. In the Detroit-Windsor community it was possible to select a number of comparable sites for study. Examples are: high, medium, and low racial income groups in low and high pollution areas; low income racial groups occupying both poor and good housing. We feel that in the study of these groups informed consideration can be given to the significant social and economic factors of income, nutrition, medical care, race, age, and family sanitation practice.

The Pilot Health Study

The conduct of a comparative health study is extremely complex, tedious, and expensive. No prototype is available for guidance. The Technical Advisory Board on Air Pollution of the International Joint Commission set up a subcommittee to plan the technical details of the study. The committee concluded that only a general plan could be evolved prior to actual field work. It was decided to develop the procedure for the general health study from a pilot study.

Organization of Community Resources

A successful health study is completely dependent upon the interest, cooperation, and support of the community. Medical and health agencies, industry, government, social agencies, the press, and the citizens must be made aware that a study is in progress. They must be convinced of its value before they will actively participate in or support it. To bring this about, a health advisory committee has been established for the Detroit-Windsor air pollution study. It is a large committee in which all phases of community life and institutions are represented.

Family Health Evaluation Techniques

The only direct method for establishing the comparative health status of population groups in the health study is through direct interview with a sufficient sample of family groups. Pairs of contrasting areas are being considered for study purposes. A sample of families in each area will be visited by a trained interviewer. At the first visit to the family the objectives of the study will be outlined and a fairly complete family history will be undertaken. Subsequent visits will be made monthly during the study to obtain detailed information on the family's health experience during the preceding month. The early phase of this work will primarily test sampling technique, forms, methods, and the response of cooperating families. During the latter phase, useful data will be collected which can be intercompared and evaluated by statistical methods.

Utilization of Existing Data

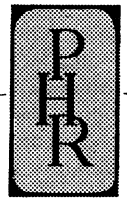
A substantial volume of pertinent health data is already being collected. The Detroit Health Department has excellent data on the geographic incidence of such diseases as tuberculosis, cancer, and pneumonia which may be

very informative if reconciled with the health area of this study. We have found that daily reports of sickness absenteeism from the medical departments of selected industries and the daily demand for substitute teachers in the public school system are useful indicators of sickness in the community. The records of physicians in selected areas of practice, allergists for example, may be especially pertinent. The city of Windsor has been conducting a general health study for some time among its residents.

Implementation of the Pilot Study

Even a pilot study of very limited scope is a time-consuming and expensive undertaking, apart from the collection of essential concurrent air pollution data. A pooling of contributions in staff and funds from the health services of the national governments, State, Provincial, and local health departments, research foundations, and community industry is necessary.

The conduct of a valid inquiry into the effect of air pollution on health is a formidable undertaking, requiring integration with concurrent environmental studies and consideration of socioeconomic factors. It must be a total study of the health status of the people of the community. It is hoped that the effect of several environmental and social factors on health will be determined at the same time. It is this hope that justifies the tremendous effort and expense the health study involves.



Clearinghouse on Morbidity Statistics Projects

A clearinghouse for current studies and surveys of morbidity has recently been established under the auspices of the Public Health Conference on Records and Statistics. The purpose of the clearinghouse is to help public health and medical workers locate specific data on diseases, injuries, and impairments, and to permit those who are planning new projects involving the measurement of illness to contact others who have undertaken similar tasks.

At regular intervals the clearinghouse will conduct a canvass of studies or surveys in progress. Lists of new projects to be released from time to time will contain brief outlines of the methods used and data to be collected. No information will be published, however, without the permission of those responsible for the project.

Inquiries about the clearinghouse may be directed to: Clearinghouse on Current Morbidity Statistics Projects, care of Division of Public Health Methods, Public Health Service, Federal Security Agency, Washington 25, D. C.